

305-CD-004-001

EOSDIS Core System Project

Overview of Release A SDPS and CSMS System Design Specification for the ECS Project

July 1995

Hughes Information Technology Corporation
Landover, Maryland

Overview of Release A SDPS and CSMS System Design Specification for the ECS Project

July 1995

Prepared Under Contract NAS5-60000
CDRL Item #

APPROVED BY

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Preface

This document, one of sixteen comprising the detailed design specifications of the SDPS and CSMS subsystems for Release A of the ECS project, provides an overview. For those reviewing the object models in detail, 305-CD-018, the Data Dictionary, may be of particular interest. A Release A SDPS and CSMS CDR Review Guide (510-TP-002) is also available.

The SDPS and CSMS subsystem design specification documents for Release A of the ECS Project include:

- 305-CD-004 Release A Overview of the SDPS and CSMS Segment System Design Specification
- 305-CD-005 Release A SDPS Client Subsystem Design Specification
- 305-CD-006 Release A SDPS Interoperability Subsystem Design Specification
- 305-CD-007 Release A SDPS Data Management Subsystem Design Specification
- 305-CD-008 Release A SDPS Data Server Subsystem Design Specification
- 305-CD-009 Release A SDPS Ingest Subsystem Design Specification
- 305-CD-010 Release A SDPS Planning Subsystem Design Specification
- 305-CD-011 Release A SDPS Data Processing Subsystem Design Specification
- 305-CD-012 Release A CSMS Segment Communications Subsystem Design Specification
- 305-CD-013 Release A CSMS Segment Systems Management Subsystem Design Specification
- 305-CD-014 Release A GSFC Distributed Active Archive Center Implementation
- 305-CD-015 Release A LaRC Distributed Active Archive Center Implementation
- 305-CD-016 Release A MSFC Distributed Active Archive Center Implementation
- 305-CD-017 Release A EROS Data Center Distributed Active Archive Center Implementation
- 305-CD-018 Release A Data Dictionary for Subsystem Design Specification
- 305-CD-019 Release A System Monitoring and Coordination Center Implementation

This document is a contract deliverable with an approval code 2. As such, it does not require formal Government approval, however, the Government reserves the right to request changes within 45 days of the initial submittal. Once approved, contractor changes to this document are handled in accordance with Class I and Class II change control requirements described in the EOS Configuration Management Plan, and changes to this document shall be made by document change notice (DCN) or by complete revision.

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Abstract

This subdocument, Release A Overview of the SDPS and CSMS Segment System Design Specification for the ECS Project, supplies a basic overview for both the SDPS and CSMS segments of the ECS project. It details the Release A components and the interactions of those components each other and with other EOSDIS components, and discusses their relationship with external entities. It describes basic factors in development of these components, and prepares the user for the more detailed analyses of subsystem designs in the in-depth series of subdocuments that follow.

This document is intended to be read by all parties interested in the Release A detailed design. For the casual reviewer this document provides a solid understanding of the ECS and Release A design. For those interested in an in-depth understanding of the detail design this subdocument provides an integrated view of the subsystems as well as certain design concepts that span subsystems. It provides the context necessary for understanding of the subsequent subdocuments.

Keywords: Release A, Volume 0, Overview, SDPS, CSMS, Design, Detailed Design, Subsystem, Architecture, Software, Hardware, Object Oriented, Security, Gateway, System Managment, Reports, User Interface, GUI.

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Change Information Page

| List of Effective Pages | | | |
|-------------------------|--------------|------------------|------------|
| Page Number | | Issue | |
| Title | | Original | |
| iii through xiv | | Original | |
| 1-1 through 1-4 | | Original | |
| 2-1 through 2-8 | | Original | |
| 3-1 through 3-10 | | Original | |
| 4-1 through 4-16 | | Original | |
| 5-1 through 5-44 | | Original | |
| 6-1 through 6-72 | | Original | |
| 7-1 through 7-6 | | Original | |
| AB-1 through AB-15 | | Original | |
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Contents

1. Introduction

| | | |
|-----|---------------------------|-----|
| 1.1 | Identification | 1-1 |
| 1.2 | Scope | 1-1 |
| 1.3 | Purpose | 1-2 |
| 1.4 | Status and Schedule | 1-2 |
| 1.5 | Organization | 1-2 |

2. Related Documentation

| | | |
|-----|--|-----|
| 2.1 | Parent Documents | 2-1 |
| 2.2 | Applicable Documents | 2-2 |
| 2.3 | Information Documents Not Referenced | 2-4 |

3. TRMM Release Overview

| | | |
|-------|---|-----|
| 3.1 | TRMM Release Objectives | 3-1 |
| 3.2 | Release A Requirements Overview | 3-1 |
| 3.3 | Release A Design Objectives and Drivers | 3-3 |
| 3.3.1 | Science Drivers | 3-4 |
| 3.3.2 | Technology Drivers | 3-5 |
| 3.3.3 | System Engineering Drivers | 3-6 |
| 3.3.4 | Policy and Funding Drivers | 3-6 |
| 3.3.5 | Other Uses | 3-7 |
| 3.3.6 | Independent Architecture Studies | 3-7 |
| 3.4 | Subsystem Design Rationale | 3-7 |

4. Release A Architecture Overview

| | | |
|-------|-------------------------------------|------|
| 4.1 | Introduction | 4-1 |
| 4.2 | Release A Context Description | 4-1 |
| 4.3 | Release A Architecture | 4-4 |
| 4.3.1 | SDPS Segment Architecture | 4-5 |
| 4.3.2 | CSMS Segment Architecture | 4-12 |

5. Release A Design Component Overview

| | | |
|-------|---|------|
| 5.1 | SDPS Components | 5-1 |
| 5.2 | CSMS Components | 5-2 |
| 5.3 | Computer Software Configuration Item (CSCI) Description | 5-3 |
| 5.3.1 | Client Subsystem..... | 5-3 |
| 5.3.2 | Interoperability Subsystem | 5-4 |
| 5.3.3 | Data Management Subsystem | 5-5 |
| 5.3.4 | Data Server Subsystem | 5-6 |
| 5.3.4 | Ingest Subsystem..... | 5-7 |
| 5.3.5 | Planning Subsystem | 5-7 |
| 5.3.6 | Data Processing Subsystem | 5-8 |
| 5.3.7 | Communications Subsystem | 5-9 |
| 5.3.8 | Systems Management Subsystem | 5-12 |
| 5.3.9 | Internetworking Subsystem..... | 5-18 |
| 5.4 | Release A Hardware Architecture..... | 5-19 |
| 5.4.1 | Hardware Component Descriptions | 5-21 |
| 5.4.2 | Performance Analysis Approach | 5-25 |
| 5.4.3 | Release A Hardware Component Classes | 5-26 |
| 5.5 | Release A LAN Architecture Overview | 5-28 |
| 5.5.1 | DAAC LAN Architecture | 5-28 |
| 5.5.2 | SMC Network Architecture | 5-31 |
| 5.5.3 | Network-based Security Architecture | 5-32 |
| 5.5.5 | Release A Network COTS Hardware | 5-34 |
| 5.5.6 | Network Backup and Recovery | 5-35 |
| 5.6 | Summary of Changes Since PDR | 5-36 |

6. Release A Cross Subsystem Design Concepts

| | | |
|-------|--|------|
| 6.1 | Distributed Communications Architecture | 6-1 |
| 6.1.1 | Overview | 6-1 |
| 6.1.2 | Distributed Object Framework..... | 6-2 |
| 6.1.3 | Universal References (URs)..... | 6-3 |
| 6.2 | Security Architecture | 6-4 |
| 6.2.1 | Driving Requirements | 6-4 |
| 6.2.2 | Information Security Strategy | 6-5 |
| 6.2.3 | OSF/DCE and OODCE Architecture..... | 6-6 |
| 6.2.4 | Security Implementation within ECS | 6-10 |
| 6.2.5 | Non-DCE Based Security | 6-12 |
| 6.3 | External Interface Architecture | 6-12 |
| 6.3.1 | Overview | 6-12 |
| 6.3.2 | Gateway Architecture | 6-14 |
| 6.3.3 | Gateway Example | 6-15 |
| 6.4 | System Management Architecture | 6-17 |
| 6.4.1 | System Management Levels | 6-17 |
| 6.4.2 | Distribution of Management Functions | 6-18 |
| 6.4.3 | M&O Positions | 6-20 |
| 6.4.4 | Division of Responsibilities | 6-23 |
| 6.4.5 | MSS Overview | 6-26 |
| 6.4.6 | Event, Exception, Error and Fault Handling | 6-30 |
| 6.4.7 | Management and Operations Reporting | 6-50 |
| 6.5 | User Interface Architecture | 6-63 |
| 6.5.1 | Release A Science User Interfaces..... | 6-63 |
| 6.5.2 | Operator User Interfaces | 6-64 |

7. Methodology Overview

| | | |
|-----|---|-----|
| 7.1 | OMT | 7-1 |
| 7.2 | OMT Diagram Tutorial | 7-2 |
| 7.3 | Event Trace Diagram Tutorial | 7-4 |
| 7.4 | State Transition Diagram Tutorial | 7-4 |

Figures

| | | |
|---------|---|------|
| 4.2-1 | TRMM Mission Key Interfaces (Release A) | 4-2 |
| 4.2-2 | LANDSAT-7 and AM-1 Key Interfaces (Release A)..... | 4-3 |
| 4.3-1 | ECS Design Segments | 4-5 |
| 4.3-2 | SDPS Subsystem Architecture | 4-6 |
| 4.3-3 | CSMS Subsystem Architecture..... | 4-14 |
| 5.4-1 | ECS DAAC Release A Hardware Architecture | 5-20 |
| 5.4-2 | Release A Architecture Component Classes..... | 5-26 |
| 5.5-1 | Release A DAAC Networks: Generic Architecture..... | 5-29 |
| 5.5-2 | SMC Network Architecture | 5-31 |
| 5.5-3 | Network-Based Security Architecture for Release A DAACs | 5-33 |
| 5.5-4 | Network-Based Security Architecture for the SMC | 5-34 |
| 6.2-1 | Conceptual DCE Cell-Based Security Architecture | 6-8 |
| 6.2-2 | Release A Security Architecture | 6-9 |
| 6.2-3 | DCE Cell Partitioning Strategy | 6-10 |
| 6.2-4 | Use of DCE within ECS..... | 6-11 |
| 6.3-1 | Gateway Architecture | 6-15 |
| 6.3-2 | Kerberos Security Gateway Example | 6-16 |
| 6.4-1 | System Management Data and Command Flows | 6-25 |
| 6.4-2 | MSS Management Flows | 6-28 |
| 6.4-3 | Manager/Agent Architecture..... | 6-29 |
| 6.5.2-1 | The GUI Implementation Method for ECS Release A | 6-67 |
| 6.5.2-2 | Model for the Development and Assessment | 6-68 |
| 6.5.2-3 | Description of the Three-Step ECS GUI Design Process | 6-69 |
| 6.5.2-4 | Sample Structure for an ECS Graphical User Interface..... | 6-71 |
| 6.5.2-5 | Print-out of Sample Showing ECS GUI Screen Structure | 6-72 |
| 7.2-1 | Object Model Diagram Notation..... | 7-2 |
| 7.2-2 | Example of an Object Model Diagram | 7-3 |

| | | |
|-------|---|-----|
| 7.3-1 | Example of an Event Trace Diagram | 7-5 |
| 7.4-1 | Example of a State Transition Diagram | 7-6 |

Tables

| | | |
|---------|--|------|
| 5.4-1 | HWCI Class Selection Rationale | 5-27 |
| 5.5-1 | Release A Network COTS Hardware | 5-35 |
| 5.6-1 | Hardware Changes Since PDR | 5-43 |
| 6.2-1 | Threat/Countermeasures | 6-7 |
| 6.4-1 | Management Service Distribution | 6-18 |
| 6.4-2 | Ops Positions and Responsibilities | 6-21 |
| 6.4.6-1 | Strawman List of Errors/Faults for SDSRV | 6-37 |
| 6.4.6-2 | Strawman List of Errors/Faults for DDSRV | 6-38 |
| 6.4.6-3 | Strawman List of Errors/Faults for DDIST | 6-39 |
| 6.4.6-4 | Strawman List of Errors/Faults for STMGT | 6-40 |
| 6.4.6-5 | Strawman List of Errors/Faults for GTWAY | 6-44 |
| 6.4.6-6 | Strawman List of Errors/Faults for DSKTP | 6-46 |
| 6.4.6-7 | Strawman List of Errors/Faults for | 6-47 |
| 6.4.7-1 | Fault Management Reports | 6-56 |
| 6.4.7-2 | Performance Management Reports | 6-57 |
| 6.4.7-3 | User Services and Accountability Reports | 6-61 |
| 6.4.7-4 | Security Management Reports | 6-61 |
| 6.4.7-5 | Configuration Management Reports | 6-61 |

Abbreviations and Acronyms

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1. Introduction

1.1 Identification

This ECS Release A Subdocument (305-CD-004-001) for the ECS Project, Contract Data Requirement List (CDRL) item, with requirements specified in data item description (DID) 305/DV3 is a required deliverable under the Earth Observing System Data and Information (EOSDIS) Core System (ECS), Contract NAS5-60000.

1.2 Scope

The Release A Detailed Design Specification (DID 305/DV3) provides integrated detailed design information of the Science Data Processing Segment (SDPS) and Communications and Systems Management Segment (CSMS) jointly referred to in this document as the Tropical Rainfall Measuring Mission (TRMM) Release or Release A. It should be noted that the Flight Operations Segment (FOS) will provide its detailed design material for the FOS CDR in a separate document.

The Release A detailed design information is presented in a series of subdocuments due to the volume of material provided. This subdocument presents an overview of the detailed design for the SDPS and CSMS. It provides an overview of the TRMM Release mission and defines the SDPS and CSMS Computer Software and Hardware Configuration Items (CI), as well as the architectural design.

This document reflects the June 21, 1995 Technical Baseline maintained by the contractor configuration control board in accordance with ECS Technical Direction No.11, dated December 6, 1994.

The remaining subdocuments are:

| | |
|----------------|--|
| 305-CD-005-001 | Release A SDPS Client Subsystem Design Specification |
| 305-CD-006-001 | Release A SDPS Interoperability Subsystem Design Specification |
| 305-CD-007-001 | Release A SDPS Data Management Subsystem Design Specification |
| 305-CD-008-001 | Release A SDPS Data Server Subsystem Design Specification |
| 305-CD-009-001 | Release A SDPS Ingest Subsystem Design Specification |
| 305-CD-010-001 | Release A SDPS Planning Subsystem Design Specification |
| 305-CD-011-001 | Release A SDPS Data Processing Subsystem Design Specification |
| 305-CD-012-001 | Release A CSMS Communications Subsystem Design Specification |
| 305-CD-013-001 | Release A CSMS Systems Management Subsystem Design Specification |

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| 305-CD-014-001 | Release A GSFC DAAC Implementation |
| 305-CD-015-001 | Release A LaRC DAAC Implementation |
| 305-CD-016-001 | Release A MSFC DAAC Implementation |
| 305-CD-017-001 | Release A EDC DAAC Implementation |
| 305-CD-018-001 | Release A Data Dictionary for Subsystem Design Specifications of the ECS Project |
| 305-CD-019-01 | Release A System Monitoring and Coordination Center Implementation |

The CSMS material provided herein includes the detailed design material for CSMS to support SMC and DAAC capabilities. This includes all services provided to Release A SDPS as well as services that are common to FOS and SDPS. CSMS services that are unique to FOS will be presented in the FOS detailed design document.

1.3 Purpose

This subdocument, Release A Overview of the SDPS and CSMS Segment System Design Specification for the ECS Project, supplies a basic overview for both the SDPS and CSMS segments of the ECS project. It details the Release A components and the interactions of those components each other and with other EOSDIS components, and discusses their relationship with external entities. It describes basic factors in development of these components, and prepares the user for the more detailed analyses of subsystem designs in the in-depth series of subdocuments that follow.

This document is intended to be read by all parties interested in the Release A detailed design. For the casual reviewer this document provides a solid understanding of the ECS and Release A design. For those interested in an in-depth understanding of the detail design this subdocument provides an integrated view of the subsystems as well as certain design concepts that span subsystems. It provides the context necessary for understanding of the subsequent subdocuments.

1.4 Status and Schedule

This submittal of DID 305/DV3 meets the milestone specified in the Contract Data Requirements List (CDRL) of NASA contract NAS5-60000. An earlier submittal was reviewed during the SDPS Preliminary Design Review (PDR) and this submittal reflects changes to the design which resulted from that review as well as the detailed design process. The PDR also triggered a number of follow up actions in response to Review Item Discrepancies (RID) the results of which have be incorporated into the Critical Design Review (CDR) version of this document.

1.5 Organization

This subdocument is organized as follows:

- Section 1.0 provides information regarding the identification, scope, purpose, status, and organization of the overall Release A Detailed Design document set as well as this subdocument.
- Section 2.0 provides a listing of related documents, which were used as source information for this subdocument.
- Section 3.0 provides an overview of the Release A objectives, requirements and design drivers. It also introduces various techniques used in the design to meet the objectives, requirements and design drivers
- Section 4.0 provides an overview Release A Architecture. The overall ECS architecture is presented and the external and cross site interfaces are discussed. The architecture is then decomposed and the Release A segments and subsystems are discussed.
- Section 5.0 provides and overview Release A design components. The Release A architecture is decomposed into software, hardware, and LAN components. These components and their role in the ECS design are presented. It also discusses changes that have occurred in the Release A design since the SDPS and CSMS Preliminary Design Reviews (PDR).
- Section 6.0 describes several design concepts that span multiple subsystems. In some cases this material is further discussed in each of the subsystem document and in other cases this is the only section it will be presented to avoid unnecessary repetition.
- Section 7.0 provides a brief tutorial on the methodology used by ECS to develop the Release A detailed design.

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2. Related Documentation

2.1 Parent Documents

The parent document is the document from which the scope and content of this Release A Overview of the SDPS and CSMS Segment System Design Specification are derived.

| | |
|-----------------|--|
| 194-207-SE1-001 | System Design Specification for the ECS Project |
| 194-219-SE1-001 | Interface Requirements Document Between EOSDIS Core System (ECS) and the NASA Science Internet (NSI) |
| 219-CD-003-002 | Interface Requirements Document Between EOSDIS Core System (ECS) and Landsat 7 System, Final |
| 194-219-SE1-004 | Interface Requirements Document Between EOSDIS Core System (ECS) and the Version 0 System |
| 194-219-SE1-005 | Interface Requirements Document Between EOSDIS Core System (ECS) and Science Computing Facilities |
| 219-CD-006-003 | Interface Requirements Document Between the EOSDIS Core System (ECS) and the National Oceanic and Atmospheric Administration (NOAA) Affiliated Data Center (ADC), Final |
| 193-219-SE1-008 | Interface Requirements Document Between EOSDIS Core System (ECS) and Program Support Communications Network, Draft |
| 194-219-SE1-015 | Interface Requirements Document Between EOSDIS Core System (ECS) and International Partners for Data Interoperability, Preliminary (formerly Interface Requirements Document Between EOSDIS Core System (ECS) and The European Space Agency) |
| 194-219-SE1-018 | Interface Requirements Document Between EOSDIS Core System (ECS) and Tropical Rainfall Measuring Mission (TRMM) Ground System |
| 194-219-SE1-019 | Interface Requirements Document Between EOSDIS Core System (ECS) and Earth Observing System (EOS) AM-1 Flight Operations |
| 194-219-SE1-020 | Interface Requirements Document Between EOSDIS Core System (ECS) and NASA Institutional Support Systems |
| 304-CD-003-002 | Communications and System Management Segment (CSMS) Requirements Specification for the ECS Project |

2.2 Applicable Documents

The following documents are referenced within this Release A Overview, or are directly applicable, or contain policies or other directive matters that are binding upon the content of this volume.

| | |
|-----------------|---|
| 194-102-MG1-001 | Configuration Management Plan for the ECS Project |
| 209-CD-001-001 | Interface Control Document Between EOSDIS Core System (ECS) and the NASA Science Internet |
| 209-CD-002-001 | Interface Control Document Between EOSDIS Core System (ECS) and ASTER Ground Data System, Preliminary |
| 209-CD-002-001 | Interface Control Document Between EOSDIS Core System (ECS) and ASTER Ground Data System |
| 209-CD-003-001 | Interface Control Document Between EOSDIS Core System (ECS) and EOS-AM Project for AM-1 Spacecraft Analysis Software |
| 209-CD-004-001 | Data Format Control Document for the Earth Observing System (EOS) AM-1 Project Data Base |
| 209-CD-005-002 | Interface Control Document Between EOSDIS Core System (ECS) and Science Computing Facilities (SCF) |
| 209-CD-006-002 | Interface Control Document Between EOSDIS Core System (ECS) and National Oceanic and Atmospheric Administration (NOAA) Affiliated Data Center (ADC) |
| 209-CD-007-002 | Interface Control Document Between EOSDIS Core System (ECS) and TRMM Science Data and Information System (TSDIS) |
| 209-CD-008-002 | Interface Control Document Between EOSDIS Core System (ECS) and the Goddard Space Flight Center (GSFC) Distributed Active Archive Center (DAAC) |
| 209-CD-009-002 | Interface Control Document Between EOSDIS Core System (ECS) and the Marshall Space Flight Center (MSFC) Distributed Active Archive Center (DAAC) |
| 209-CD-011-002 | Interface Control Document Between EOSDIS Core System (ECS) and the Version 0 System |
| 304-CD-001-002 | Flight Operations Segment (FOS) Requirements Specification for the ECS Project, Volume 1: General Requirements |

| | |
|-----------------|--|
| 304-CD-002-002 | Science Data Processing Segment (SDPS) Requirements Specification for the ECS Project |
| 304-CD-004-002 | Flight Operations Segment (FOS) Requirements Specification for the ECS Project, Volume 2: Mission Specific |
| 305-CD-002-002 | Science Data Processing Segment (SDPS) Design Specification for the ECS Project |
| 305-CD-003-002 | Communications and System Management Segment (CSMS) Design Specification for the ECS Project |
| 308-CD-001-003 | Software Development Plan for the ECS Project |
| 313-CD-004-001 | Release A CSMS/SDPS Internal Interface Control Document for the ECS Project |
| 601-CD-001-004 | Maintenance and Operations Management Plan for the ECS Project |
| 604-CD-001-004 | Operations Concept for the ECS Project: Part 1-- ECS Overview |
| 604-CD-002-001 | Operations Concept for the ECS project: Part 2B -- ECS Release B, Annotated Outline |
| 604-CD-003-001 | ECS Operations Concept for the ECS Project: Part 2A -- ECS Release A, Final |
| 194-813-SI4-001 | Instrument Support Toolkit Prototype Results for the ECS Project |
| 194-WP-905-002 | System Management Service Distribution for the ECS Project, White Paper, Working Paper |
| 194-WP-907-002 | EOSDIS Core System Communications and Systems Management Architecture, White Paper, Working Paper |
| 193-TP-632-001 | DME Migration Study for the ECS Project |
| 222-TP-003-006 | Release Plan Content Description for the ECS Project |
| 540-TP-001-001 | CSMS Preliminary Design Review Trade Studies for the ECS Project |
| 543-TP-001-003 | A Cost Comparison of Transferring Inter-DAAC Data via Media vs the ESN WAN, Version 3 |
| 423-41-03 | Goddard Space Flight Center, EOSDIS Core System (ECS) Contract Data Requirements Document |
| none | Goddard Space Flight Center, EOS AM-1 Ground Systems Requirements |

2.3 Information Documents Not Referenced

The following documents, although not referenced herein and/or not directly applicable, do amplify and clarify the information presented in this document. These documents are not binding on the content of the Release A Overview.

| | |
|-----------------|--|
| 205-CD-001-002 | Science User's Guide and Operations Procedure Handbook [for the ECS Project], Parts 1-3 |
| 205-CD-002-001 | Science User's Guide and Operations Procedure Handbook for the ECS Project, Part 4: Software Developer's Guide to Preparation, Delivery, Integration and Test with ECS |
| 206-CD-001-002 | Version 0 Analysis Report for the ECS Project |
| 209-CD-010-001 | Interface Control Document Between EOSDIS Core System (ECS) and the Langley Research Center (LaRC) Distributed Active Archive Center (DAAC) Draft |
| 194-302-DV2-001 | ECS Facilities Plan for the ECS Project |
| 101-303-DV1-001 | Individual Facility Requirements for the ECS Project, Preliminary |
| 194-317-DV1-001 | Prototyping and Studies Plan for the ECS Project |
| 318-CD-003-XXX | Prototyping and Studies Progress Report for the ECS Project (monthly) |
| 333-CD-003-001 | SDP Toolkit Users Guide for the ECS Project |
| 601-CD-001-004 | Maintenance and Operations Management Plan for the ECS Project |
| 101-620-OP2-001 | List of Recommended Maintenance Equipment for the ECS Project |
| 194-703-PP1-001 | System Design Review (SDR) Presentation Package for the ECS Project |
| 193-801-SD4-001 | PGS Toolkit Requirements Specification for the ECS Project |
| 194-813-SI4-002 | Planning and Scheduling Prototype Results Report for the ECS Project |
| 194-813-SI4-003 | DADS Prototype One FSMS Product Operational Evaluation |
| 194-813-SI4-004 | DADS Prototype One STK Wolfcreek 9360 Automated Cartridge System Hardware Characterization Report |
| 813-RD-009-001 | DADS Prototype Two Multi-FSMS Product Integration Evaluation |
| 828-RD-001-002 | Government Furnished Property for the ECS Project |
| 193-WP-118-001 | Algorithm Integration and Test Issues for the ECS Project |
| 193-WP-611-001 | Science-based System Architecture Drivers for the ECS Project, Revision 1.0 |

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|----------------|--|
| 193-WP-623-001 | ECS Evolutionary Development White Paper |
| 194-WP-901-002 | EOSDIS Core System Science Information Architecture, White Paper, Working Paper |
| 194-WP-902-002 | ECS Science Requirements Summary, White Paper, Working Paper |
| 194-WP-904-002 | Multi-Track Development for the ECS Project, White Paper, Working Paper |
| 194-WP-913-003 | User Environment Definition for the ECS Project, White Paper, Working Paper |
| 194-WP-914-001 | CORBA Object Request Broker Survey for the ECS Project, White Paper, Working Paper |
| 194-WP-918-001 | DADS Prototype One FSMS Product Operational Evaluation, White Paper, Draft Report |
| 194-WP-925-001 | Science Software Integration and Test, White Paper, Working Paper |
| 420-WP-001-001 | Maximizing the Use of COTS Software in the SDPS SDS Software Design, White Paper |
| 193-TP-561-001 | Technical Paper: DCE Migration Study for the ECS Project |
| 193-TP-626-001 | GCDIS/UserDIS Study ECS Technical Paper, Draft 0.2 |
| 194-TP-266-002 | Data Distribution Architecture Logical Object Model (LOM) for the ECS Project, Version 2.01 |
| 194-TP-267-001 | Data Server Architecture Logical Object Model (LOM) for the ECS Project, Version 2.00 |
| 194-TP-313-001 | ECS User Characterization Methodology and Results |
| 194-TP-316-001 | Data Compression Study for the ECS Project |
| 194-TP-548-001 | User Scenario Functional Analysis [for the ECS Project] |
| 194-TP-569-001 | PDPS Prototyping at ECS Science and Technology Laboratory, Progress Report #4 |
| 222-TP-003-006 | Release Plan Content Description for the ECS Project |
| 430-TP-001-001 | SDP Toolkit Implementation with Pathfinder SSM/I Precipitation Rate Algorithm, Technical Paper |
| 440-TP-001-001 | Science Data Server Architecture Study [for the ECS Project] |
| none | Hughes Training, Inc., ECS User Interface Style Guide, White Paper, Version 4.0 |

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|---------------------|---|
| 423-16-01 | Goddard Space Flight Center, Data Production Software and Science Computing Facility (SCF) Standards and Guidelines |
| 423-41-02 | Goddard Space Flight Center, Functional and Performance Requirements Specification for the Earth Observing System Data and Information System (EOSDIS) Core System |
| 540-022 | Goddard Space Flight Center, Earth Observing System (EOS) Communications (Ecom) System Design Specification |
| 560-EDOS-0211.0001 | Goddard Space Flight Center, Interface Requirements Document Between EDOS and the EOS Ground System (EGS) |
| 502-ICD-JPL/GSFC | Goddard Space Flight Center/MO&DSD, Interface Control Document Between the Jet Propulsion Laboratory and the Goddard Space Flight Center for GSFC Missions Using the Deep Space Network |
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3. TRMM Release Overview

3.1 TRMM Release Objectives

The objectives of the TRMM Release (Release A) are to provide ECS components to support the TRMM mission; Version 0 Data Access; EOS-AM-1 and Landsat 7 Interface Testing; and EOS-AM-1 Algorithm Integration and Test. The objectives are met through deliveries of capabilities to four DAAC sites: Langley Research Center (LaRC), Marshall Space Flight Center (MSFC), Goddard Space Flight Center (GSFC) and EROS Data Center (EDC).

The TRMM mission support includes ingest of CERES and LIS L0 data for TRMM; ingest of ancillary data for TRMM product generation; CERES and LIS product generation, archive, and distribution; receipt and archive of data products from TSDIS; and TRMM product data management, search, and access capabilities.

Version 0 (V0) Migration includes the ability to transition some V0 data sets from V0 to EOSDIS Version 1 (V1) which includes ECS Release A; and provide support, data management, search, and access capabilities for these data sets. A subset of V0 data sets is available at Release A start-up. Additional data migration takes place during Release A operations.

EOS-AM-1 interface testing includes testing EDOS/ECS interfaces and ADC/ECS interfaces required for EOS-AM-1 ancillary data. Hardware and software components provide capabilities to exchange messages and transfer data. Message validation and limited data checking is supported. Temporary storage of messages and data is provided to validate the EOS-AM-1 interfaces. Interface testing is also provided for the ingest of data from Landsat-7.

Science Software Integration and Test includes support to integrate Version 1 science software for EOS-AM-1 instruments into the DAAC. Science Software Integration and Test supports receipt of Algorithm Packages and validates the science software will operate correctly in the DAAC environment through standards checking, integration with the SDP Toolkit, and execution on the DAAC processing resources.

3.2 Release A Requirements Overview

The ECS Release A system supports the services required to provide hardware, software, and operations to ingest, process, archive, manage, and access data and related information from the entire EOSDIS and to interconnect users and service providers, transfer information between the ECS and many EOSDIS components, and manage all ECS components. Release A builds on the initial set of capabilities provided in Incremental Release 1 (Ir-1), an early version of the system provided for TRMM interface and science software integration and test.

More specifically, the Release A science data processing capabilities will include the following:

- TRMM Operational Data Processing Support. With the initial staging of the ECS environment accomplished in Ir-1, Release A provides the full operational capability for

the ingest and archival of TRMM data for CERES and LIS instruments, and product generation, receipt, archive and distribution of TRMM data products received from TSDIS, with metadata, ancillary data and the Level 1-4 (L1-L4) science products archive capabilities at the GSFC and MSFC; and with LIS and CERES capabilities at LaRC and MSFC.

- TRMM Ancillary Data from ADCs. Ancillary data interfaces with the National Oceanic Atmospheric Administration (NOAA) National Environmental Satellite Data and Information Service (NESDIS) and the Goddard Space Flight Center (GSFC) Data Assimilation Office (GDAO) provide ancillary data for TRMM processing.
- Early Landsat-7 Interface Testing. Release A provides capabilities for early interface testing between ECS at EDC and the Landsat-7 Landsat Processing System.
- Early EOS AM-1 Interface Testing. Release A provides capabilities for early interface testing of EOS AM-1 ground system interfaces among several facilities including the Flight Dynamics Facility (FDF), the Aster Ground Data System, NOAA/NESDIS, the DAO, the ECS Data Operation System (EDOS), and three DAACs - LaRC, GSFC, and EDC.
- Science Software Integration and Test (SSI&T). Release A is responsible for providing tools and scripts to facilitate the SSI&T for V2 CERES and LIS TRMM instruments and V1 of all EOS-AM-1 instruments.
- Science Data Access. Release A provides user interfaces for accessing data in ECS repositories, including access to all data migrated from Version 0 into ECS data servers. Through reuse of the Version 0 Information Management System (IMS) and its V0 access capabilities, Release A also provides access to data still held in V0 data servers.

All of these capabilities are provided by the hardware, software, and operations of the Science Data Processing Segment (SDPS) of the ECS Release A. Further details on these requirements are provided in ECS Science Requirements Summary White Paper (FB9402V2).

In addition, Release A will provide a number of communications and connectivity capabilities through its Communications and System Management Segment (CSMS):

- ECS interfaces with Nascom Operation Local Area Network (NOLAN) for the ingest of Level 0 TRMM data at Marshall Space Flight Center (MSFC) and Langley Research Center (LaRC).
- ECS interfaces with the EOSDIS Science Network (ESN) to support links among the Release A Distributed Active Archive Centers (DAAC) and Goddard Space Flight Center (GSFC) Data Assimilation Office (GDAO) and National Oceanic Atmospheric Administration (NOAA) for the exchange and archive of mission-related science products and ancillary data sets required by Release A.
- ECS supports status exchange between TRMM sites and Release A ECS DAACs.
- ECS requirements include use of the EOSDIS Backbone Network (EBnet) to support early AM-1 mission testing with interfaces between EOS Data and Operations System

(EDOS) and ECS. These interfaces include exchange of mission-related spacecraft and instrument control data required by FOS for early interface testing.

- ECS supports access from Version 0, local institutional network, and NSI EOSDIS user communities, including TRMM scientists. These interfaces facilitate exchange of various Release A data items (e.g., science products, algorithms, ancillary data sets) as well as interactive access sessions with SDPS and CSMS services.
- ECS provides operations, management, and maintenance personnel with local and in some cases remote access to its enterprise management services to support reporting of a wide range of status information, coordination, and performance of administration and maintenance services.
- ECS also provides local area networks for the workstations, servers, and peripheral components within each ECS DAAC.

A more detailed overview of ECS Release A capabilities and plans can be found in the Mission Statement for the TRMM Release for the ECS Project, White Paper 420-WP-003-001.

3.3 Release A Design Objectives and Drivers

The design for Release A was influenced by a number of important objectives. Foremost among them are the following:

- Supporting the requirements of the Tropical Rainfall Measuring Mission (TRMM), providing Version 0 migration, and providing the capabilities needed by interface and science software integration & test for later missions (as discussed above).
- Ensuring a smooth upgrade of system capabilities and capacities to accommodate Release B, which follows Release A only nine (9) months later.
- Providing a basis for implementing the system design objectives of the ECS architecture presented at SDR. These objectives include allowing for evolution, extensibility, scalability, technology insertion, component reuse and site autonomy.

These objectives and the design drivers discussed below presented challenges for the Release A design team. The design not only supports the TRMM Mission objectives but provided the basis for future releases and system evolution. Release A design mitigates risks posed by the various objectives and design drivers in order to meet the schedule of the TRMM Mission Release. This required careful balancing by the design team of the objectives and design drivers against the Release A schedule feasibility.

Between SDR and the Critical Design Review (CDR), numerous trade studies and prototyping activities were undertaken to support the design decisions. The trades and prototyping efforts are reported in the Trade-off Studies Analytical Data (211-CD-001-001). This document discusses important design alternatives, especially where decisions are still open, and aspects of evolution to Release B where they directly affected Release A design decisions. However, the focus of this document is the presentation of the Release A design itself.

In consequence, the following briefly reviews the Release A design rationale in the wider context of the original design drivers. A review of the SDR system architecture and how it relates to the Release A design is presented in Section 4. The design drivers fall into the following main categories:

- science drivers
- technology drivers
- system engineering drivers
- policy and funding drivers
- other uses of ECS technology
- independent architecture studies

3.3.1 Science Drivers

The science drivers were derived from various inputs from the scientific community, including those developed by the user and data modeling efforts, input from various science working groups, feedback from regularly scheduled teleconferences between design teams and the science community, and visits with research teams associated with the SCFs. They are described in various white papers and technical reports (e.g., Science-based System Architecture Drivers for the ECS Project, ECS White Paper [193-00611], EOSDIS Core System Communications and Systems Management Architecture White Paper [MR9401V2], User Scenario Functional Analysis [194-00548], and ECS User Characterization Methodology and Results [194-00313]), and can be summarized as follows:

- Facilitate an efficient data search and access paradigm which is easy to use and will be able to deal with sharp variations in access demands
- Support an environment in which scientists can conduct their investigations using information resources in a highly interactive fashion
- Create an infrastructure which is capable to support logical data collections enriched with science information at various levels of abstraction and presentation
- Support the integration of independent investigator tools with those provided by ECS which facilitate the access to ECS data and the use of ECS services
- Facilitate the collaboration among scientists, for example, by making it easy to exchange information and collect data of common interest for shared access and distribution to the community
- Support a dynamic product life cycle and easily extensible product set, while maintaining full version control over science products and source data which are used to generate them
- Provide a data production capability which can accommodate routine and on-demand processing, gives scientists visibility into predicted production schedules as well as production history, and can manage complex data dependencies and processing contingencies.

- Support advances in communications infrastructure and interoperability
- Protect against unwanted Application Programming Interface (API) changes throughout the ECS lifecycle
- Provide distributed administration and control to support site autonomy

3.3.2 Technology Drivers

Advances in computer and communications technology will enhance the future abilities of scientists to search, access, and process information in a large system such as EOSDIS, and will do so in a perhaps dramatic fashion over the life time of ECS. This will affect the ways in which users of the system will work. ECS needs to anticipate these changes such that design decisions made now make it possible to support future paradigm shifts. Key among the technology drivers affecting ECS are the following:

- Advances in the fundamental software infrastructure of an evolving information technology industry. These include developments in:
 - Operating systems that support network-based distributed computing
 - Distributed processing and interoperability protocols
 - Object-oriented databases and object-extended relational models, including support for heterogeneous, distributed databases
 - Distributed object-based network services
- Networking advances, including the potential for Gigabit communications based on advancing network technologies like Asynchronous Transfer Mode (ATM).
- Processing advances, including the continuing performance increases anticipated in desktop workstations, the clustering of such workstations in cooperative problem solving, and the next generation of Massively Parallel Processors (MPP), and the expected advances in I/O associated with processing.
- Advances in permanent storage technologies offering higher densities, higher access rates, and vastly reduced storage costs.
- Advances in multimedia technology which promises desktop video-conferencing and sophisticated workstation-based collaboration environments.

For example, whereas in the near term, bulk data will often be transferred using physical media, it is likely that within a few years, real-time access to browse images and on-line transfer of bulk data is possible. It is not unlikely that within the next ten years, substantial portions of the archive can be staged on-line, enabling direct access to archive data by science programs. It is important that the design of the ECS capabilities which support ordering and distribution of data, or the storage and management of data, will not prohibit the new ways of data access that such radical progress in technology and technology cost will enable.

3.3.3 System Engineering Drivers

The ability of the ECS design to evolve in the future is an important aspect of system engineering. An in-depth discussion of ECS evolvability is contained in the ECS Evolutionary Development White Paper [193-00623]. Release A implements the ECS architecture, as reviewed during SDR, even though many of the ECS characteristics which have been presented at SDR are not required for Release A because of its limited scale. The following are just a few examples.

- ECS is adopting distributed objects as its long term distributed network computing strategy. Release A makes heavy use of distributed objects. The interfaces between distributed software components follow this paradigm to smooth the path for future transition.
- Release A will put in place the framework for a distributed advertising service.
- Release A will adopt the distributed infrastructure presented at SDR and PDR, for example, supporting Universal References (UR) and data search and access sessions between clients and servers.
- Release A will support popular Internet access standards like Wide Area Information Servers (WAIS) and HyperText Transport Protocol (http), and ECS will continue to track these Internet technologies and evolve with them.

3.3.4 Policy and Funding Drivers

EOSDIS will serve a diverse number of organizations over its 20 year mission. There will most certainly be a need to adapt to changes in future budgets, funding policies, and management philosophies. ECS must be design to respond to these shifts without significant impact. The demands for and the priorities of data products will also vary over time, and the system must be able to react to such changes. This may include redirecting some portion of product generation computing resources, or employing additional resources from, say, a National Science Foundation (NSF) super-computing center, to the production of key research products. For example, such activities might be undertaken in response to a phenomenological event.

Policy and funding drivers are discussed in detail in the 'Science Information Architecture White Paper' [FB9402V2]. Important policy changes which the ECS design may need to respond to include:

- where data is generated
- what is archived vs. what is created when needed
- resource allocation to specific functions, user types, etc.

This requires a design which parameterizes policy where possible rather than embedding it in software, supports dynamic resource allocations and priorities, and can cope with variations in policy across sites. Care has been taken to ensure that the Release A design decouples software design and policy wherever possible.

3.3.5 Other Uses

During its 1993 review of NASA's EOSDIS program, the National Research Council (NRC) recommended that EOSDIS be designed such that all users (EOS, non-EOS investigators, DAACs, other data centers) can build selectively on top of EOSDIS components without constraining local implementation of diverse functions or the autonomy of their organization or management. This would permit the EOSDIS program to collaborate in the development of a general multi-agency Global Change Data and Information System (GCDIS), and an expanded version open to general earth science data providers and users (UserDIS).

In response to these recommendations, NASA undertook a study of the potential role for ECS in GCDIS and UserDIS. The GCDIS / UserDIS Study White Paper [193-00626] presents a dimension of this driver category, in evaluating the needs of a larger community than ECS directly supports. The study explores the concept of an all-encompassing Earth Science information federation, based on complete subsystems like ECS, and linked into a larger "information superhighway." It also attempts to establish a larger context of which ECS is a part, in order that ECS might be able, through its development, to establish standards and components that could be adopted by the global change community at large.

The results of the GCDIS/UserDIS study were an important influence on the design of ECS, primarily because the flexibility and openness of the GCDIS/UserDIS solution closely matched the perceived science drivers discussed above. Release A design follows the concepts laid down during SDR in terms of distribution, interoperability and autonomy.

3.3.6 Independent Architecture Studies

During the system design activity leading up to SDR, three independent architecture studies were initiated with teams from George Mason University, University of California and the University of North Dakota. These teams developed independent concepts for the ECS architectural design and presented the results in September, 1993 to the EOSDIS project, the science community, and the ECS project. Many of their technical recommendations confirmed the SDPS architecture presented at PDR. For example, there was consensus among the studies that ECS needs to be firmly based on concepts of distributed computing and databases, be able to take advantage of the rapidly declining costs of computing technology, and fit into a wider earth science information network. The ideas presented by the teams have influenced SDPS and CSMS trade studies, for example, the DBMS prototype, the DCE Encapsulation Study, and the Science Data Server Architecture Study.

3.4 Subsystem Design Rationale

The Release A software and hardware architecture, presented in the following section, responds to a number of system wide issues:

- *Reliable production and archiving of earth science data* -- Production planning, processing, and ingest subsystem software services are designed to support graceful degradation and effective recovery. For example, production is automatically switched away from failed resources, processing which cannot be switched due to unique

requirements is suspended, and production adjusts to reduced production capacity based on priority. The design provides flexibility to handle various types of quality assurance for products, on-site as well as off-site. Production history is retained to allow reprocessing in case of data loss. Hardware designs utilize techniques for reducing the likelihood of failures as well as their impact on system operation, such as fault resistant technologies (e.g. RAID staging, FDDI communications, redundant communications switches and cross connections, fault resistant archive robotics, etc.), and resource pooling to permit graceful degradation in emergency or maintenance situations to prevent catastrophic loss of services.

- *Large I/O streams* -- The hardware design employs high speed, low latency technologies coupled with resource pooling to spread I/O loads across multiple system components, reducing the possibility of points of contention and bottlenecks. Examples are the use of multi-tiered local area networks (LAN) provided by CSMS, employing of dedicated sub networks where needed and sharing RAID storage between major system components.
- *Large and long term persistent storage* -- The design makes it possible to divide the resources into sub-domains for use by data collections and their data servers to spread I/O and resource control over many file servers, and apply heterogeneous storage and access technologies on a site by site basis.
- *Scalability* -- Software components are designed for distributed operation and for replication of servers on multiple platforms already in Release A. The design uses a flexible hardware topology to permit scaling in a variety of manners, for example, provisions exist for the insertion of new storage technology, and the design uses a non-monolithic approach to file server, archive and I/O hardware. Industry standards are employed where possible to provide stable interfaces for future scale-up in hardware. For example, production planning and management will support the execution of product generation algorithms in a distributed environment and support changes in processing topology and the nature of processing resources; data servers are architected for operating in a locally distributed environment using shared and/or dedicated resources as necessary.
- *Easily extensible product set* -- The software managing the earth science data collection borrows from database management technology to hide the physical organization of data from users and programs; describe the logical aspects of data products in a data server schema and a data dictionary; and include the facilities needed to create these definitions for new products and bring them 'on-line'.
- *Evolvability* -- The design decomposes the system into services which have well defined interfaces that do not reveal their internal design and adopt interfaces which can be ported to evolving new technologies; adopt open system standards where they are available and design the system to be able to use foreseeable open system standards when they become industry supported.
- *Open architecture to support integration of independent investigator tools* -- The design provides a 'tool-neutral' client subsystem and includes facilities for inserting new tools into the desktop and workbench, for example, a framework for associating tools with data (e.g., as the default viewing tool); format translators and a framework for extending them;

using a uniform mechanism for referencing ECS data and objects which is built around the Internet http protocol.

- *Flexible data search and access paradigm* -- The Release A design provides direct search and access to specific data collection. It contains all the hooks which will be needed to provide data search and access at the distributed system and site level later. Concepts include browsing and searching of advertisements; access to data dictionaries to obtain information about and explanations of products and their parameters; interconnecting the information services into a web of related descriptions accessible, for example, through Mosaic.
- *Low cost of entry* -- The design minimizes the requirements and costs for hosting and obtaining ECS access software. For example, access to a subset of the information (e.g., documents, advertisements) is possible through popular Internet tools such as Mosaic. The basic data access and viewing tools in the workbench will carry no license restrictions, can be widely distributed, and will be available for a number of UNIX platforms.
- *Preservation of site autonomy* -- The ECS design is such that users and science programs need not be aware of site internal policies and hardware / software architecture. Coordination among sites will not require centralized authority. For example, planning and processing subsystem services do not assume centralized operational or planning control.
- *Ability to relocate services and data* -- The design minimizes the impact of data or service relocation on users and programs, for example, by using a logical method for referencing data and services (the Universal Reference) and by providing data exchange functions to automate the exchange of the metadata associated with any relocated information.
- *Providing components for GCDIS and UserDIS* -- GCDIS/UserDIS concepts have been included into the design where feasible and compatible with Release A schedule. Portability of key components across UNIX platform was and is an important design consideration. For example, Advertising, Data Dictionary, and Data Server Services are designed to support the needs of a heterogeneous data and information network consisting of autonomously managed sites.
- *Data integrity and security* -- ECS data will be accumulated at great expense to the nation, and is intended for use in policy decisions which may have long term impact. Protecting the integrity of this data and safeguarding essential ECS processing capabilities while providing open access to the system has been a key concern in the design of the ECS communications and access services.

While trade-off decisions had to be made during the design to ensure that Release A will meet the schedules dictated by TRMM requirements, care has been taken to accommodate these objectives. For example, data server, planning, ingest, and processing subsystem designs are heavily influenced by the demands for scalability to Release B and beyond; the data server subsystem design was driven by the need to provide reliable archiving of data, accommodate an extensible product set, and support a flexible data search and access paradigm.

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